MODIS Albedo and Reflectance Anisotropy Products for Climate and Vegetation Studies

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Abstract

Land surface albedo, the reflected proportion of the incident radiant flux, is identified as an Essential Climate Variable (ECV) by GCOS and is required globally by climate, biogeochemical, hydrological, and weather forecast models at a variety of spatial and temporal scales. Since albedo depends on the unique anisotropy of the surface (related to the intrinsic composition and structure of the natural and anthropogenic land cover), remote sensing offers the only viable method of measuring and monitoring the heterogeneity of global land surfaces.

The MODIS albedo and reflectance anisotropy products have been available since early 2000 and have utilized both Terra and Aqua acquisitions since mid-2002. The operational MODIS BRDF/Albedo algorithm makes use of a kernel-driven, linear model of the Bidirectional Reflectance Distribution Function (BRDF) that relies on the weighted sum of an isotropic parameter and two functions (or kernels) of viewing and illumination geometry (Roujean et al., 1992). One kernel is derived from radiative transfer models (Ross, 1981) and the other is based on surface scattering and geometric shadow casting theory (Li and Strahler, 1992). The kernel weights selected are those that best fit the cloud-cleared, atmospherically-corrected surface reflectances available for each location over a 16 day period (Lucht et al., 2000; Schaaf et al., 2002). Once an appropriate anisotropy model has been retrieved, integration over all view angles results in a directional-hemispherical reflectance (DHR) or a black-sky albedo, at any desired solar angle and a further integration over all illumination angles results in a bihemispherical reflectance (BHR) under isotropic illumination, or a white-sky albedo.

These albedo quantities are intrinsic to a specific location and can be combined with appropriate optical depth information to produce an actual (blue-sky) albedo for a specific time, such as would be measured at the surface by field sensors under ambient illumination. The anisotropy models can also be used to compute surface reflectances at any other view or solar zenith angle desired (e.g. they are

frequently used to correct multiple swaths for view angle effects and provide nadir BRDF-adjusted reflecances (NBAR) for land cover classification, land use change detection and phenological studies). These spectral quantities can also be combined via narrow to broadband conversion coefficients (Liang et al., 1999) to provide broadband anisotropy information and thus accurate broadband albedos equivalent to those routinely collected in the field with pyranometers and commonly used in large-scale models. Gap-filled, snow-free versions of the products have been prepared specifically for climate modeling applications by fitting annual phenological curves to the retrievals successfully accomplished every 8 days and using this curve to estimate periods missing due to cloud-contamination and ephemeral snow-cover (Moody et al., 2008). MODIS albedo and anisotropy quantities are currently being used by a variety of climate modeling and forecast teams (Lawrence and Chase, 2007; Myhre et al., 2005; Morcrette et al., 2008) and an overview of the validation and application of this successful product over the past decade will be provided.

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